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DEVICE FOR THE ANALYSIS OF THE SURFACE STATE OF THE GROUND FOR A MOBILE UNIT SUITABLE FOR ESTABLISHING CONTACT WITH THAT GROUND

[Dispositif d'analyse de l'état de surface d'un sol pour mobile apte à prendre contact avec ce sol]

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This invention relates to devices suitable for being mounted on mobile units such as, for example, highway vehicles, making it possible to analyze the surface state of the ground with relation to which these mobile units must move and, more particularly, those that are in contact with the ground at least at one point, for example, via the tires.

More and more vehicles are moving on highways everywhere and at all times; that entails major risks of accidents. In view of this fact, certain officials thought of putting together a complete information network to link most of these vehicles to each other in order, on the one hand, to inform the drivers of certain parameters that would enable them to adapt the quality of their driving but also, on the other hand, to be able to use the vehicles themselves as mobile detectors capable of picking up certain parameters. Thus, for example, we already have shock detectors that transmit Hertzian signals when the vehicle with which they are equipped has become involved in an accident. This detector then alerts the drivers of other vehicles heading toward the accident site; they can thus take all useful precautions in order, for example, to avoid becoming entangled in another accident. As a

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[1]Numbers in the margin indicate pagination in the foreign text.

matter of fact, in this case, the road is generally heavily crowded and it is therefore rather important to slow down and possibly even to change the itinerary.

With this objective in mind, one of the first parameters that is important to know has to do with the surface state of the ground, in particular, to find out whether the ground is dry, wet, icy, snowy, etc. in order to be able to derive from this an entire grouping of data that will help ensure good movement conditions in a given area. More particularly, it is important to be able to determine the exact places on the highways that are iced because that condition in the winter is a predominant cause of accidents and it is almost impossible to anticipate with certainty those places where the major axes of movement are in that particular state.

In this context, the object of this invention is to provide a device with a rather simple and reliable structure that could yield worthwhile results which, in turn, would help ensure good travel conditions, especially for automotive vehicles. /2

More precisely, this invention is intended to provide a device for analyzing the surface state of the ground for a mobile unit that is liable to establish contact with that

ground in at least one point, characterized in that it comprises the following:

- a first source of a first beam of radiation of the electromagnetic type;

- first means for bringing together said source with said mobile unit so as to direct said beam toward a point on said surface;

- a first receiver of a beam of the same type, said receiver being capable of delivering first signals that are representative of the beam that is received;

- second means for bringing together said first receiver with said mobile unit so as to direct its access of reception essentially upon said point on said surface, being capable of picking up at least one portion of said beam reflected upon said point and

- first processing means of said first signals capable of being emitted by said first receiver.

Other features and advantages of this invention will appear during the following description given with respect to the attached drawings by way of illustration but without any restriction, where:

- Figure 1 represents a basic diagram of one mode of implementation of a device according to the invention applied to the equipment of a vehicle of the automotive type and

- Figure 2 represents a detail of the implementation of the device according to Figure 1.

Figure 1 shows a device 1 that makes it possible to analyze the surface state of the ground 2 for a mobile unit 3 capable of establishing contact with that ground in at least one point 4, for example, an automotive vehicle 5 moving on a highway 6, the points of contact 4, 8 being those that are common to tires 7 and to the road 6.

Device 1 comprises a first source 10 of a first beam 11 of radiation of the electromagnetic type. Source 10 is interlocked with vehicle 5, for example, on the chassis by means of a clip 12 so as to direct the beam that it emits toward a point 13 on the surface of road 6. The device also comprises a first receiver 14 chosen so as to be able to deliver signals at its output 15, for example, of the electrical type representative of the beams it receives. This receiver 14 is also brought together with the vehicle, for example, by means of an attachment clip 16 so as to direct the axis of its reception field 17 essentially toward point 13 on the surface of road 6 in order to be able to pick up at least

one portion 18 of beam 11 reflected upon the surface of the ground at point 13. Output 15 of that receiver 14 is connected to an input of a processing member 60 for the signals that are delivered in order to be able to analyze them, compare them, etc. in order to deduce from that, as will be explained later, the actual state of the road surface. /3

To be able to determine the surface state of road 6 with even greater precision and possibly to eliminate certain uncertainties, the device also comprises a second source 22 of a second beam 23 of electromagnetic radiation, said source 22 being mounted upon the vehicle, for example, by means of a clip 24 so as to direct beam 23 which it emits into a volume 25 passing in the vicinity of point of contact 8 of tire 7 with ground 2 and advantageously in such a way that this beam 23 passes just behind point 8 of the tire with respect to the normal direction of progression 26 of vehicle 5 in order to be able to illuminate the projections 27 produced by that tire when it rolls on a roadway covered with elements of all kinds, for example, water, snow, gravel sand, etc. This beam 23 will be relatively fine and will have a certain orientation, especially with respect to the ground in order to pick up only projections 27, eliminating the reflections upon the ground so as not to risk any confusion with these projections. For

example, this beam could, if possible, be parallel to the ground or at least could be arranged in such a fashion that its point of intersection with the ground would be situated as far as possible away from the place where such projections are generally produced.

To analyze the nature of these projections, the device comprises a second receiver 30 capable of picking up a portion 31 of the second beam 23 sent by these projections 27, said second receiver being capable of delivering second signals at its output that are representative of that portion of beam 31. Of course, that receiver 30 is also attached upon vehicle 5, for example, by means of an attachment clip 32. These second signals are then transmitted to a processing member that cooperates with the first. /4

The device advantageously also comprises, still for the purpose of eliminating any possible undetermined aspects regarding the nature of the surface state of the ground, a third receiver 33 of an electromagnetic beam capable of emitting third signals that are representative of the beam received, said third receiver being mounted upon vehicle 5, for example, by means of a clip 35 so as to be able to pick up at least one portion 34 of the first beam 11 that is diffracted or retroreflected by the surface of ground 2 at

point 13. The signals delivered by that receiver 33 are transmitted to a third processing member which cooperates with the other two.

In an advantageous embodiment of the invention, the three processing members are represented by one and the same microprocessor 60 having suitable programming as will be explained later on.

In the embodiment described so far, providing a maximum volume of data in the form of signals, the device thus comprises three receivers 14, 30, 33. However, to get a better analysis of the beams that are received, the receivers and, more particularly receiver 14, are made up of a plurality of surfaces 40 that are sensitive to the electromagnetic radiation emitted, especially by source 10. These sensitive surfaces 40 are juxtaposed upon a reception surface, for example, a planar surface, but advantageously a concave curve passing through all of the image points created, said surface being capable of also being formed by elements of planar surfaces distributed on curves in order better to receive the beams and thus to process the signals emitted by said receivers.

The above description mentions the fact that one employs electromagnetic radiation here. For the purpose of employing

reliable and relatively inexpensive elements, it is advantageous to pick sources of radiation of the optical type.

In this case, the sensitive surfaces 40 for the reception of the reflected or diffracted beams are made up of converging optical elements 41 and a plurality of photosensitive cells 42 placed at a point of focalization of these converging elements 41, said optical elements, for example, consisting of converging lenses. /5

In this same case of optical radiation, the optical elements can be made up of a single objective associated with a reception target of the video type arranged in its plane of convergence, the target then being analyzed sequentially by elementary surfaces of a determined area. By way of example of a worthwhile manner of implementation, both in technical terms and in commercial terms, the target consists of a photosensitive matrix system with charge transfer.

As mentioned earlier, when the radiation is radiation of the optical type, the two sources 10 and 22 are advantageously made up, as illustrated in Figure 2, of a laser generator 50, for example, a laser of the helium-neon type 51 comprising an output window 52 through which emerges a fine and only slightly divergent beam 59. Upon this beam, there is deposited a separator 53, for example, a partly reflecting and

transmissible thin plate 54, which generates two distinct beams 55, 56 on two different optical paths. These two beams then constitute the two beams 11 and 23 defined above. Of course, the separator can possibly also comprise a reflecting mirror that makes it possible to direct the two beams, as described above, upon the different points of the surface of the ground, especially 13 and 27. Such a mirror or reflecting slide was illustrated as 57 in a single copy, and beam 58, emitted at the output of said thin plate constituting the beam that illuminates projections 27, may possibly traverse an optical element of the divergent type, for example, a divergent lens, in order to give the beam sufficient width to illuminate the quantity of projections necessary in order to secure their identification with the greatest precision possible while preserving a certain degree of fineness to prevent the above-mentioned inconveniences and to discern any possible parasite reflections. /6

The device described above works in the following manner:

It must be stated first of all that this operation will be described in terms of its use on an automotive vehicle traveling on a road currently taken by such vehicles and whose ground surface is made up of an asphalt road surface with the

device employing optical radiation, for example, in the visible range.

If one keeps in mind that the vehicle moves on that road when it is dry and not covered with fine gravel, then beam 11, emitted by source 10, is almost totally absorbed by the surfacing and receivers 14, 30 and 33 thus do not receive any signal since the surface does not reflect anything nor is anything diffracted since no projection is generated. The absence of the signal at the output of the three receivers is analyzed by processing member 60 which, at its output, defines the state of the ground as that of a dry ground not covered with fine gravel or the like.

In the case where the dry ground is covered, for example, with fine gravel, receiver 30 receives a feedback from beam 31 produced by way of reflection and/or diffraction of beam 23 upon said particles, whereas the two other receivers do not receive any beam and at their output do not deliver any signal. The processing member thus in this case makes it possible to analyze the state of the road as being that of a dry road but covered with fine gravel.

If one considers that the road is wet, receiver 30 receives a beam due to diffraction upon the projections of water drops produced by the tire upon said wet road.

Moreover, the surface of point 13 is covered with water and that water behaves almost like a reflecting surface. Receiver 14 then receives a relatively concentrated beam, whereas receiver 30 receives a beam with zero intensity or with a very weak amplitude. The signals delivered at the output of the receivers are analyzed by processing member 60 that announces that the surface of the ground is wet.

If one assumes that the ground is icy, the surface at point 13 behaves like a plurality of reflecting surfaces in a rather random distribution due to the crystalline nature of the glaze of ice. Receiver 14 then receives a plurality of beams distributed in a relatively large volume and the surface of the exposed receiver is very big, which makes it possible to detect the reflection in the case of a wet ground as against a reflection due to an icy ground. Receiver 13, in turn, receives no bundle because generally a tire rolling on glazed ice does not generate any projections. As for receiver 33, it can by way of retroreflection receive a beam of variable intensity. The signals delivered by the receivers are analyzed by processing member 60 and make it possible to classify the ground as being "covered with a glaze of ice." /7

Of course, it is possible to determine other ground surface states, for example, a ground surface covered with

snow. As a matter of fact, the snow produces much more diffraction than does water and almost as much as glazed ice. This absence of specific determination is easily cleared up by the fact that in contrast to glazed ice, the rolling action of a tire on snow does produce projections. In this case, receiver 30 receives a relatively intensive beam and thus delivers a signal that is analyzed by processing member 60.

It appears that the device described above makes it possible with rather very good precision to analyze the various surface states of roads currently taken by automotive vehicles. It is thus conceivable that processing member 60 might be connected with a transmitter in order to transmit the results obtained and to process then in terms of an entire given region and even an entire country or more. It is obvious that the adjustment of the device and the program for the processing member will be easily worked out by an expert in the field who is familiar with the data explained above without any need for developing these points any further here.

CLAIMS /8

1. Device for analyzing the surface state of a ground (2) for a mobile unit (3) capable of establishing contact with said ground by at least one point (4, 8), characterized in that it comprises the following:

- a first source (10) of a first beam (11) of radiation of the electromagnetic type;

- first means for bringing together (12) said source with said mobile unit so as to direct said beam toward a point (13) on said surface;

- a first receiver (14) capable of receiving a beam (18) of the same type, said receiver being capable of delivering (15) first signals that are representative of the beam that is received;

- second means to interlock (16) said first receiver with said mobile unit so as to direct its access of reception (17) essentially upon said point (13) on said surface (2), being capable of picking up at least one portion of said beam reflected upon said point and

- first processing means (60) of said first signals capable of being emitted by said first receiver.

2. Device according to Claim 1, characterized in that it comprises the following:

- a second source (22) of a second beam (23) of electromagnetic radiation;

- third means for attaching (24) said second source of radiation upon said mobile unit in order to direct said second

beam into a volume (25) passing in the vicinity of said point of contact (8);

- a second receiver (30) to pick up a portion (31) of said second beam (23) returned by particles (27) situated in said volume (25), said second receiver being capable of delivering second signals that are representative of said portion of the beam that was picked up;

- fourth means for interlocking (32) said second receiver (30) with said mobile unit so that said receiver may be capable of picking up said portion of the beam that is returned by the particles and

- second processing means (60) for said second signals emitted by said second receiver cooperating with said first processing means (60). /9

3. Device according to one of Claims 1 and 2, characterized in that it comprises the following:

- a third receiver (33) of electromagnetic radiation beam, said third receiver being capable of emitting third signals representative of the received beam;

- fifth means for interlocking (35) said third receiver with said mobile unit so as to be able to receive at least one portion (34) of said first beam (11) after diffraction by the surface of the ground (6) upon said point (13) and

- third processing means (60) for said third signals cooperating with said first and second processing means.

4. Device according to any of the above claims, characterized in that at least one of said receivers (14, 30, 33) comprises a plurality of sensitive reception surfaces (40), said sensitive surfaces being juxtaposed upon a reception surface.

5. Device according to Claim 4, characterized in that with said electromagnetic radiation being an optical radiation, said sensitive reception surfaces (40) are made up of optical convergence elements and a plurality of photosensitive cells (42), said cells being situated essentially at the point of convergence of said optical elements.

6. Device according to Claim 5, characterized in that said optical elements are made up of convergent lenses.

7. Device according to Claim 5, characterized in that said optical elements are made up of an objective, a video reception target arranged on a plane of convergence of said objective and means for sequential analysis by elementary surfaces of said target.

8. Device according to Claim 7, characterized in that said target is made up of a photosensitive matrix system with charge transfer.

9. Device according to Claims 2 and 5, characterized in that the first (10) and second (22) sources are made up of a generator (51) of a laser beam (59) and at least one separator (53) of the beam emitted by said generator in order to give rise to two beams (55, 56) on two different paths. /10

10. Device according to Claims 2 and 3, characterized in that said first, second and third processing means are made up of a microprocessor (60).

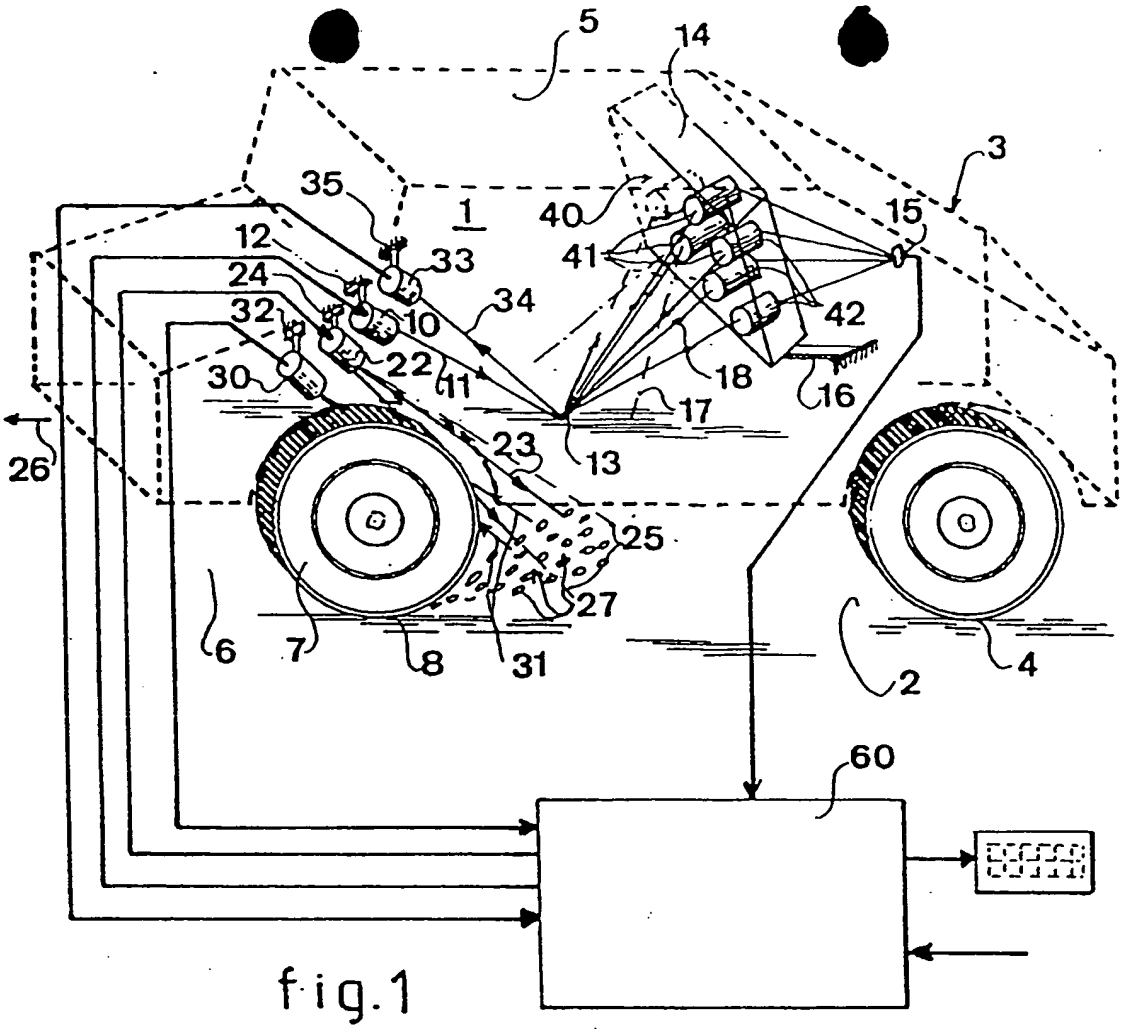
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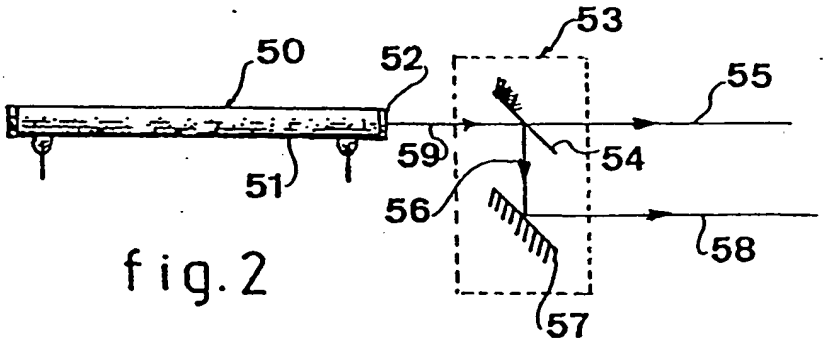
fig.1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